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CT metric probe of the lumbar vertebral ratios among Jazan population(KSA)

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Abstract *Measurements of the pedicle width, pedicle height, spinal canal width and vertebral body width are the most popular measurements in vertebra, but reason that made this study interesting ,was the measurement of all lumbar vertebral ratios including spinal canal ratio, pedicle(CT)ratio as well as the unique measurement for the pedicle index. Our study aimed to institute a baseline data by the analysis of the (pedicle index: the ratio of the pedicle width to the pedicle height) (pedicle ratio or CT ratio: the ratio of pedicle width to the vertebral body width) and the (spinal canal ratio: the ratio of the spinal canal width to the to the vertebral body width)at each lumbar vertebral level(L1-L5) among Jazan population using CT scan.*

This study was a prospective and descriptive, using a reviewed CT images for lumbar vertebrae (L1to L5). It consisted of 200adult participants [100males and 100 females] The mean age of the total patients was 41.77 years (range between 19 and 75 years).The three lumbar vertebral ratios were: the ratio of the pedicle width(PDW) to the pedicle height(PDH)), (pedicle ratio or CT ratio: the ratio of pedicle width (PDW) to the vertebral body width (VBW))and the (spinal canal ratio: the ratio of the spinal canal width(SCW)to the to the vertebral body width (VBW).All were measured in millimeter, using statistical analysis. The mean of the lumbar vertebral pedicle index ratios gradually increased from L1 to L5,these ratios were greater in females than males, mean of the CT ratios also demonstrated gradually increasing from L1 to L5and their ratios also greater in females than males whereas the results of the mean of the spinal canal ratios were gradually decreasing from L1 to L5and the spinal canal ratios were greater in males than females.

Lumbar vertebral ratios structural knowledge might be helpful for the clinicians in the images diagnoses and orthopedic surgeon in plan for surgery of lumbar spine anomalies. It acts also as a useful database for Jazan population which can be assisted in the further spinal researches.

Keywords: *ratio; lumbar vertebrae; morphometry, pedicles.*

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I. Introduction

Several studies have been conducted to determine morphometry of lumbar vertebra[1]and [2]as knowledge of high precision of human lumbar vertebra anatomy is necessary not only for the understanding of biomechanical and functional feature of lumbar spine but also for various interventions such as; safe placement of screws in pedicle fracture, correction of deformities or degenerative changes, vertebroplasty, pediculoplasties, discography, discectomy, vertebral biopsy as well as pre surgical planning and designing surgical instruments[3],and with the help of screws, various devices such as rods, plates or wires can be applied to spine for immobilization or fixation [4].Transpedicular fixation has become the most frequently used technique in lumbar spine arthrodesis due to its biomechanical superiority and the observed clinical improvement compared with other available vertebral fusion systems [5]; [6].Most anatomical studies on morphology of lumber pedicle have been reported in white population, Asian patients, American and African with a few report in Arab zone in spite of these anatomical constraints in the lumbar spine. However there are no existed reports about the vertebrae in Saudi population with the exception of that found by[7], [4].

Accurate anatomical descriptions of the shape and orientation of lumbar is also important to distinguish differences in morphometry of vertebrae in men and women and to understand changes in the elderly [8] as incorrect placement of instruments and devices may have serious complications [9].

Most of studies have been carried out using fresh cadaver [10] [11] or osteological collections with the help of vernier caliper. Computerized tomographic(CT) images have been employed more recently to study

lumbar vertebrae [1] and[15],and it's used in morphometric analysis of lumbar spine measurements in this study.

Computed tomography (CT) scans, with an established accuracy for evaluating pedicle dimension, are most commonly used as the best radiologic tool for measuring various radiographic pedicle parameters [1], [12]and [13].In comparison with the CT scan, it is well known that plain radiograph is a relatively inaccurate way to evaluate pedicle diameter because of various three dimensional structures with different transverse and sagittal angles of pedicle at each spine level[14].

The aim of the present study was to establish a baseline data by the analysis of the(pedicle index: the ratio of the pedicle width(PDW) to the pedicle height(PDH)), (pedicle ratio or CT ratio: the ratio of pedicle width (PDW) to the vertebral body width (VBW))and the (spinal canal ratio: the ratio of the spinal canal width(SCW)to the to the vertebral body width (VBW)) at each lumbar vertebral level(L1-L5) in Saudi Arabian[Jazan population] using CT scan, to find more accurate estimations of pedicle diameters and indices and the lumbar spinal canal diameters which may help clinicians for interpret and plan for proper treatment of lumbar anomalies such as; spinal canal stenosis. The only report found related to the characteristics of CT ratio or pedicle ratio PWD/VBW done by (Kang.,et al 2011)[14] who hypothesized that CT scan is a trustable radiologic imaging modality to provide precise measurements of PDW and VBW,VBW measured on true anteroposterior radiographs incorporates less measurement error because the shape of the vertebral body has nearly circular profile, and the approximate value of a true PDW could be determined using the VBD as measured on plain radiographs and the mean CT ratio of PDW/VBW at each spine level.

II. Materials & Methods

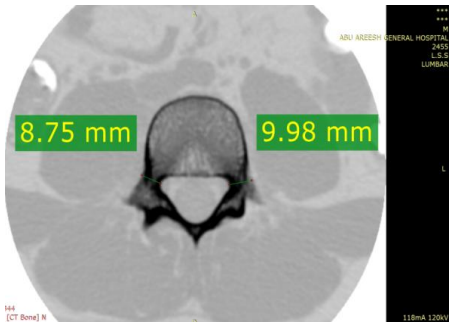
The study was an observational, prospective, descriptive and comparative morphometric study based on a review of CT images by measuring the dimension of the lumbar spine.200 patients[100male and 100female],The mean age of the total patients was 41.77years (range between 19 and 75 years), with the mean age of 100 male being 41.36 years (range 20–75years) and the mean age of 100 female patients being 40.70years (range 19–75 years). The study sample analyzed *two thousand* pedicles, *one thousand* morphometrically normal lumbar vertebral body and canal from (L1to L5) of the*two hundred* patients.The lumbar vertebrae were analyzed prospectively with CT scans, patients were selective randomly according to their fulfilling the inclusion criteria [age above 18] and exclusion criteria [patients with a certain degree of skeletal pathology which was interpreted by their chronic back pain, back pain related to age factor, arthritis prior back surgery, pregnancy and degenerative conditions, spondylolisthesis, retrolithesis, and disk space collapse.]study was performed between March 2016 and April2020. Data were collected from CT units of governmental hospitals in Jazan region after permission verbally from head of the medical imaging departments in the region in a form of lumbar CT or abdominal CT images using USB flash or CD-ROM. No patient data were published also the data was kept in personal computer with personal password. Data were then analyzed using DICOM viewer [RadiAnt DICOM Viewer 4.6.9 (64-bit) reviewed April 14, 2019] however some cases were independently measured and analyzed in the PACS rooms in some hospitals in the region, by *radiologists* to rule out scans that showed symptomatic of the spine because these conditions can alter the size or composition of the vertebral pedicle. All data collected were presented as mean±SD values by using of the (SPSS version 19,SPSS Inc., Chicago,USA))There was official permission to Jazan governmental hospitals to take the data. Patients' height and weight were not considered in this study like that done by others studies.

Measurements of Pedicle index(PI) :

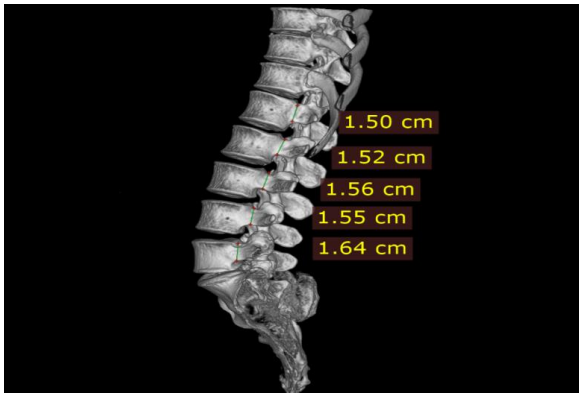
It's the ratio of the pedicle width to the pedicle height at each lumbar vertebral level:

Pedicle index = Pedicle width (PDW)/Pedicle height (PDH)

Pedicle width (PDW)was measured using the CT axial views in the transverse plane, it is the distance between medial and lateral surfaces of pedicle at its midpoint, measured at right angles to the long axis of the pedicle, also known as (isthmus), transverse or axial width. As proposed previously [15], the pedicle axis was defined as a line perpendicular to and bisecting the narrowest diameter of the pedicle. Both right and left pedicles width were measured, (Figure1) whereas the Pedicle Height (PDH) was measured from the 3D reconstruction images using the lateral approach in the sagittal plane. This is the maximum diameter of the pedicle It is the vertical distance between superior and inferior border of pedicle at its midpoint isthmus. Both right and left pedicles height were measured. (Figure2).



(Figure 1) Demonstrated measurements of the right and left pedicles of the (PDW) using axial MPR images at the level of (L4) *(Zindrick et al.1987[15]method).*

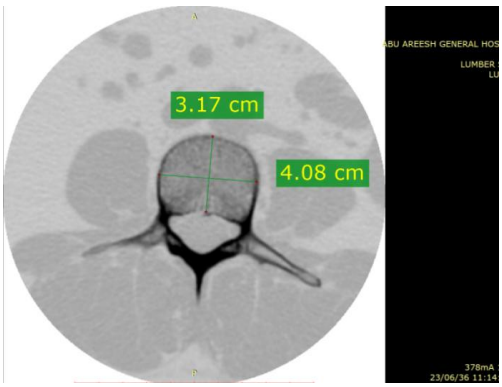


(**Figure2):** demonstrated measurements of the left Pedicle Height (PDH):using 3D reconstruction images.

Measurements of pedicle ratio or (CT ratio):
The ratio of pedicle width (PDW) to the vertebral body width (VBW).

Pedicle ratio (CT ratio) = Pedicle width (PDW)/Vertebral body width (VBW)

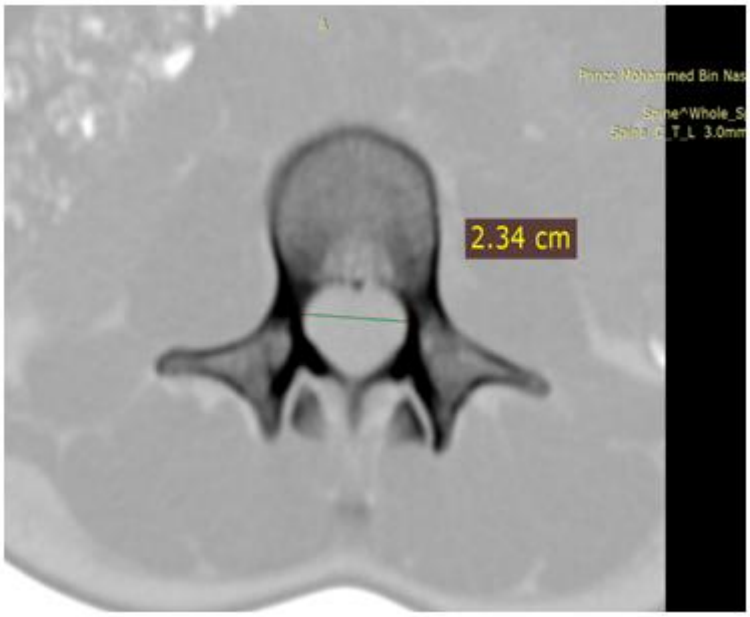
For the knowledge of the pedicle width (PDW) measurement see (Figure 1)
Vertebral body width (VBW) was measured using the CT axial views in the transverse plane, vertebral body width measurements, include the distance between the lateral borders of the vertebral body in the transverse plane of the cranial endplate, i.e. it's the widest distance between the lateral borders of the vertebral body. The Transverse diameter of the vertebral body, measured from the external cortex of the right border to the external cortex of the left border**.** *(Urrutia et al.,2009).* (Figure.3)



(Figure.3)Demonstrated measurement of both the Vertebral Body Width (VBW) and the Vertebral Body Depth (VBD) using axial MPR images at the level of (L3) as reported and measured by *(Urrutia et al.,2009)[16].*

Spinal canal ratio: Spinal canal ratio SCW/VBW Mean spinal canal width /Mean vertebral body width.
Spinal canal width (SCW) or (interpedicular diameter)using the axial CT plane, it's the maximum distance between the medial surfaces of the right and left isthmuses of the vertebral pedicles**,** it was measured and *also*

recorded as the transverse diameter of the vertebral foramen width as *described* and measured by *(Jones, Thomson,.1968[17]* Transverse diameter of the spinal canal. Described as the distance that exists between the external cortex of the medial border of both pedicles according to *(Urrutia et al.,2009[16]*.(Figure 4).*For the knowledge of the* vertebral body width(VBW) measurement (Figure 3)



(Figure.4) Demonstrated measurement of the Spinal Canal Width (SCW) or (interpedicular diameter) using axial MPR images at the level of (L3) as reported and measured by *(Jones, Thomson,.1968)[17] and (Urrutia et al.,2009)[16]*

III. RESULTS

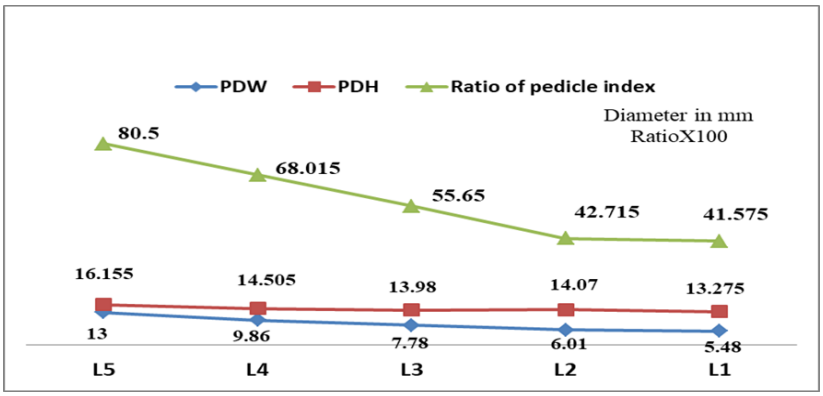
(Table.1): Demonstrated pedicle width &pedicle height (mean ± SD, mm):

Vertebral Level	Pedicle width (PDW)			Pedicle height (PDH)		
	Male	Female	Total	Male	Female	Total
L1	5.56±.95	5.39±.68	5.48±.828	13.36±1.83	13.19 ± 1.86	13.275±1.84
L2	5.98±.653	6.04±.83	6.01±1.74	14.04±1.91	14.1±1.92	14.07±1.95
L3	7.67±.75*	7.89±.65	7.78±2.70	13.98±1.25	13.98± 1.20	13.98±1.225
L4	9.74±.900	9.99±1.17	9.86±1.05	14.57±1.64	14.44±1.50	14.505±1.57
L5	12.99±1.29	13.02±1.05	13.00±1.17	16.19 ±1.41	16.12±1.52	16.155±1.465

* Significant difference of pedicle width diameter between male and female ($P<0.05$)also there was statistically insignificant difference of the pedicle height between female and male at the lumbar level ($P>0.05$)

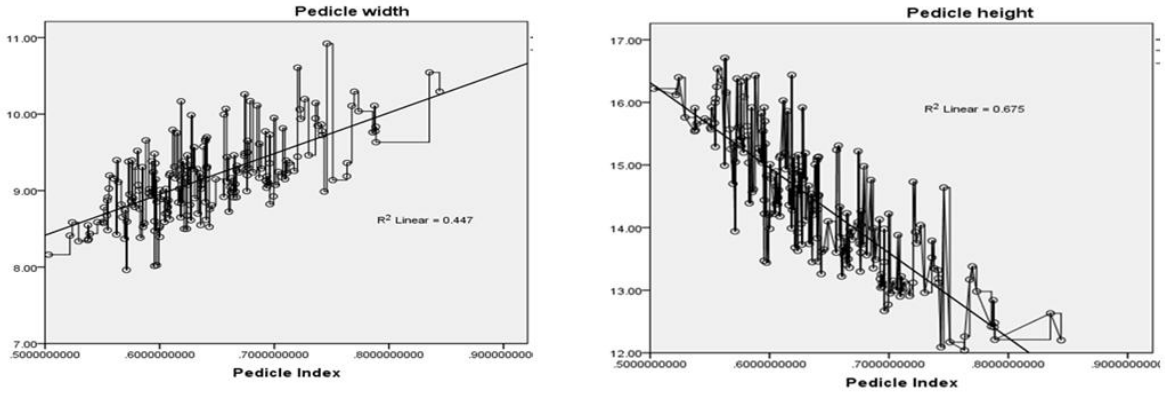
(Table.2): Depicted the ratio of pedicle width to pedicle height (mean ± SD, %):

Vertebral Level	Pedicle index		
	Male	Female	Total
L1	42.29± 4.15	40.86±3.05	41.575±3.6
L2	42.59± 3.22	42.84±3.75	42.715±3.485
L3	54.86± 3.30	56.44±2.81	55.65±3.055
L4	66.85± 3.98	69.18±3.63	68.015±3.805
L5	80.23± 4.54	80.77 ± 4.66	80.5±4.6



(Figure.5) Demonstrated the mean PDW, PDH, and the ratio of (PDW/PDH X 100) L1–L5 are demonstrated on a linear graph

The results found that the pedicle index curve is more similar to both the PDW (r2 = 0.447) curve and the PDH (r2 = 0.675) curve especially at lumbar levels of L1– L3, PDW curve demonstrated positive linear relationship with Pedicle index and PDH curve demonstrated negative linear relationship with Pedicle index(Figure.6).



(Figure.6): demonstrated that the pedicle index curve is more similar to both the PDW (r2 = 0.447) and the PDH (r2 = 0.675) curve , especially at lumbar levels of L1–L3,PDW curve depicted positive linear relationship with Pedicle index and PDH curve depicted negative linear relationship with Pedicle index.

Pedicle ratio (CT ratio) = (PDW)/ (VBW)

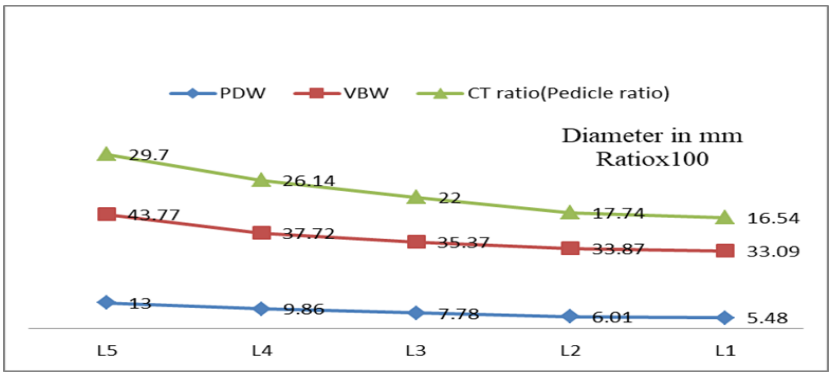
(Table 3): Depicted the Pedicle width& vertebral body width (mean ± SD, mm):

Vertebral Level	Pedicle width (PDW)			Vertebral body width		
	Male	Female	Total	Male	Female	total
L1	5.56±.95	5.39±.68	5.48±.828	33.29±2.80	32.90±2.54	33.09± 4.00
L2	5.98±.653	6.04±.83	6.01±1.74	34.02±2.66	33.72±2.23	33.87± 4.11
L3	7.67±.75*	7.89±.65	7.78±2.70	35.78±2.66	34.97± 2.63	35.37± 4.66
L4	9.74±.900*	9.99±1.17	9.86±1.05	38.11±2.73	37.32±2.20	37.72± 3.88
L5	12.99±1.29	13.02±1.05	13.00±1.17	43.97±3.09	43.57±2.51	43.77± 4.89

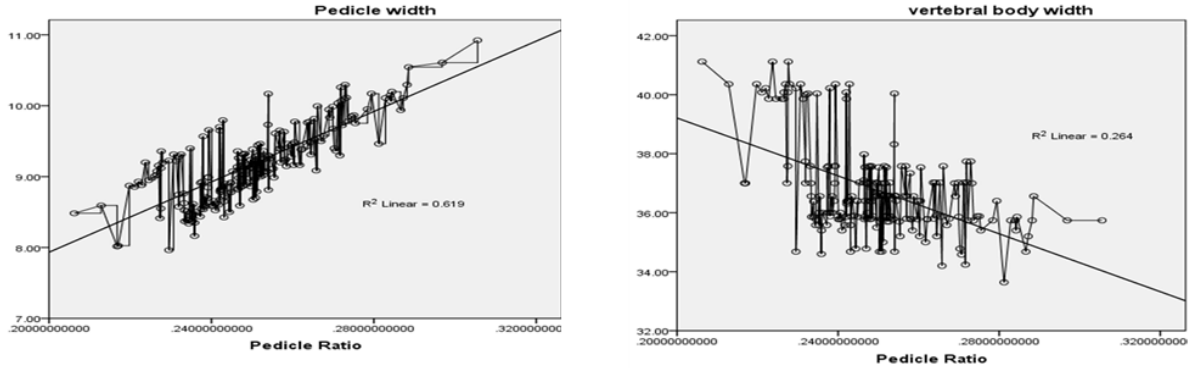
(Table.4)Demonstrated Pedicle ratio or CT ratio of the pedicle width to vertebral body width (mean ± SD, %):

vertebral Level	CT ratio (pedicle ratio)		
	Male	Female	Total
L1	16.70 ± 2.45	16.38 ± 2.07	16.54 ± 4.16
L2	17.58 ± 2.00	17.91 ±2.77	17.74 ± 4.35
L3	21.44 ± 2.13	22.56± 2.81	22.00± 3.88

L4	25.56 ± 2.98	26.77± 2.55	26.14± 3.95
L5	29.54± 2.54	29.88 ± 3.66	29.70± 4.56



(Figure.7): The mean PDW,VBW,and the ratio of (PDW/VBWX100) L1–L5 are demonstrated on a linear graph.



(Figure.8):Demonstrated that the pedicle ratio curve is more similar to the PDW curve (r2 = 0.619) than the VBW (r2 = 0.264) curve, especially at lumbar levels of L1–L2,PDW curve depicted highly positive linear relationship with Pedicle ratio and VBW curve depicted negative linear relationship with Pedicle ratio.

Spinal canal ratio: SCW/VBW

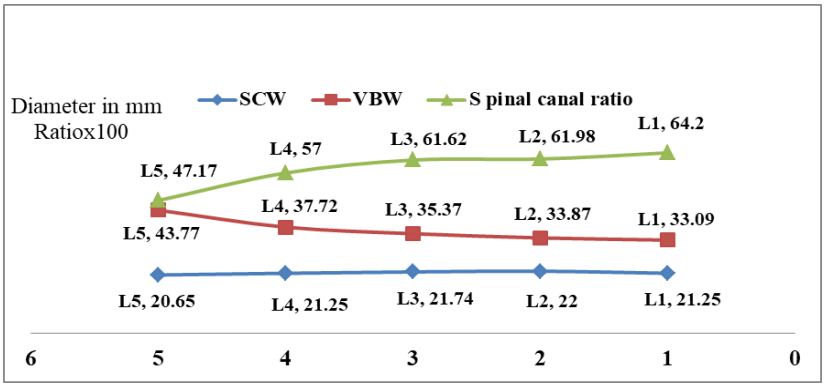
(Table5): Demonstrated the (SCW) and (VBW) (mean ± SD, mm):

Level	Spinal canal width(SCW)			Vertebral body width (VBW)		
	Male	Female	Total	Male	Female	Total
L1	21.36 ±1.24	21.14±1.1	21.25 ± 1.26	33.29±2.80	32.90±2.54	33.09± 4.00
L2	21.21±2.00	20.78±2.4	22.00± 2.2	34.02±2.66	33.72±2.23	33.87± 4.11
L3	22.04±2.90	21.45±2.5	21.74 ± 2.7	35.78±2.66	34.97± 2.63	35.37± 4.66
L4	22.04±2.90	20.96±2.7	21.25 ±2.8	38.11±2.73	37.32±2.20	37.72± 3.88
L5	20.85±2.89	20.45±2.5	20.65 ± 2.70	43.97±3.09	43.57±2.51	43.77± 4.89

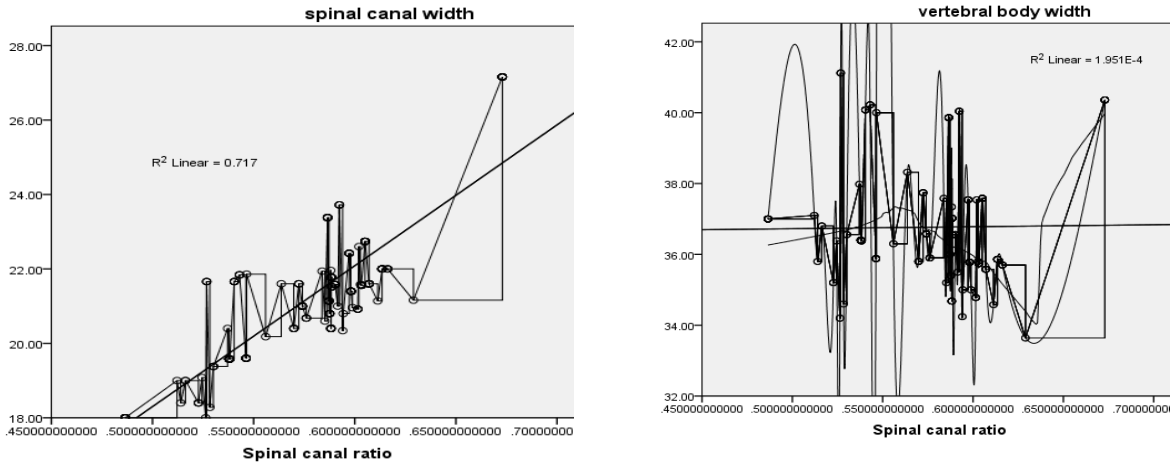
(Table 6): Demonstrated the ratio of the spinal canal at each level (mean ± SD, %):

Level	Spinal canal ratio		
	Male	Female	Total
L1	64.16 ± 2.02	64.25± 3.05	64.20 ± 3.83
L2	62.34 ± 2.33	61.62 ± 3.75	61.98 ± 3.35
L3	61.60 ± 2.78	61.65 ± 2.81	61.62 ± 3.19

L4	57.83± 3.98	56.16± 3.63	57.00 ± 3.94
L5	47.42 ± 4.54	46.93 ± 4.66	47.17 ± 4.6



(Figure.9):The mean SCW,VBW and the ratio of (SCW/VBWX100) L1–L5 are demonstrated on a linear graph.



(Figure10):A. The mean SCW, VBW, and the ratio (SCW/VBWx100) for L1–L5 are depicted on a linear graph. B. The Spinal canal ratio curve is more similar to the SCW (r2 = 0.717) curve than the VBW (r2 = 1.951E) curve, along lumbar vertebral levels of L1–L5. SCW curve demonstrated a positive linear relationship with spinal canal ratio and VBW curve depicted no linear relationship with spinal canal ratio.

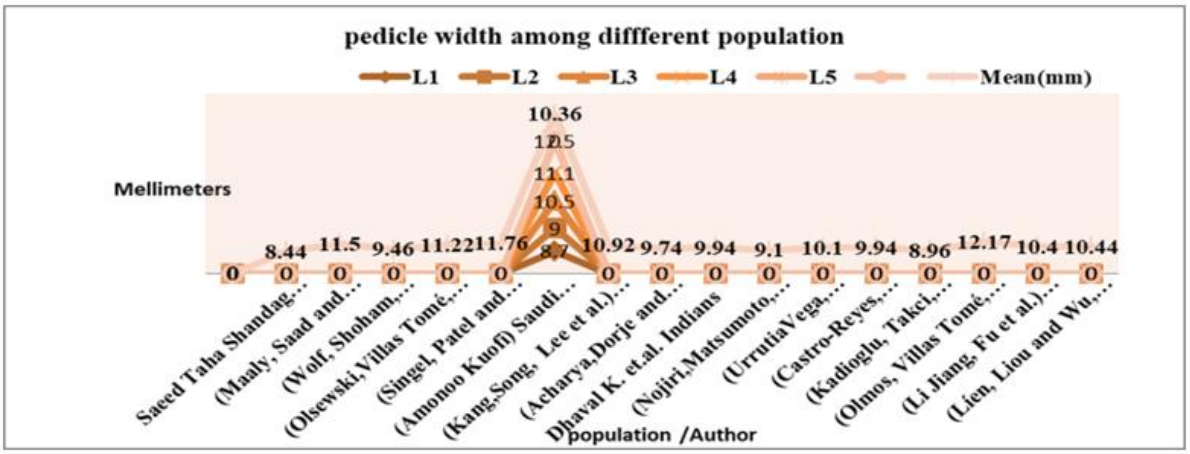
IV. Discussion

Vertebral column morphology is influenced by various factors such as environmental and mechanical factors of our everyday lifestyle and internally by hormonal, genetic and metabolic factors. These all affect its ability of everyday life to react to the dynamic forces which are much influenced by occupation, locomotion and posture [18].The lumbar pedicle has been the object of many morphometric studies in different populations around the world to determine their true dimensions using direct measurement in cadavers spines [19,20,21,22]and the measurement of dry vertebrae [21,23, 24, 25] plain radiography, fluoroscopy, 3D reconstruction, magnetic resonance imaging and computed tomography (CT) such as; [1,9,12,26,27,14,2,29 ,30 ,31, 32,3,8 ,16 ,33 15] as well as the current study.

The largest mean lumbar pedicle width was seen at vertebral level L5 in both males (12.99±1.29) and females (13.024±1.047) and the least was at vertebral level L1 in both males (5.56±.948) and females (5.3901±.68104) . The minimum (5.39mm) and maximum (13.023mm) readings for both male and female pedicles width were noted both at (female L1) and (female L5) respectively. In all the vertebral levels, the mean pedicle width was slightly larger in females than in males and the difference was statistically insignificant (p >0.05) except at vertebral level L1 .The result of our study demonstrated that the mean values of pedicle width of L3 in male (7.6 mm) was slightly smaller than that of L3 female (7.88 mm). lumbar vertebrae increased gradually from L1 to L5 in both males and females. The mean (PDW) of the pedicle in males was (8.39 ± 1.23) mm and in females was 8.47 ± 1.17 mm.

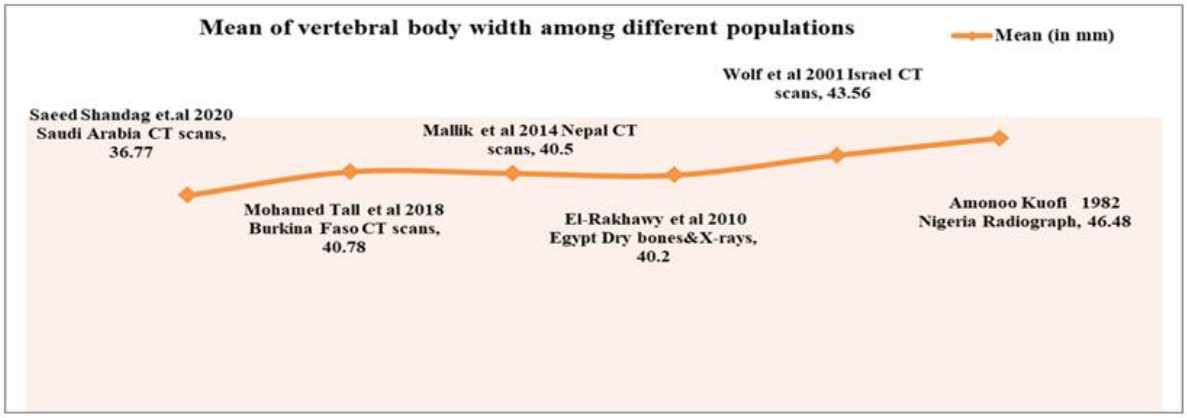
The results of pedicle width in our study(Jazan population)compared with different populations are

demonstrated in (Figure 11),these studies depicted corresponding with our study in gradually increase in pedicle width from L1 to L5,and there was a great variation between our results with other races and ethnicities at each vertebral level in the mean values, although some populations showed close or slightly close corresponding with our results such as; Turkish [27], Israelites.[33], Indians [9], Chinese [34]. Mexicans [16] and Japanese.[35]The figure result also convinced that there was a great variation in (PDW) between this study and the study of Amoono kaufi in 1995 among Saudi Arabians though both studies were employed in the same country but in different region and the method of each study [4] used the plain radiograph where our study used CT scan as a method of measurement.



(Figure11)The (PDW) of lumbar spine of the present study were compared with the data from previous studies.

Pedicle height also influences pedicle screw selection. However, in all studies, it has been established that the pedicle height is always greater than the pedicle width [21]). Our study agrees with this finding. Some authors claim that pedicle height should not be considered as a morphometric parameter for proper selection of a transpedicular screw [36].The study results convinced that there was no great variation in (PDH) between this study and that of Amoono kaufi in 1995 among Saudi Arabians as both studies were employed in the same country but with different in regions and the method of each study [4] used the plain radiograph where in our study we used CT scan as a method of measurement. One study [4] depicted that the height of pedicles in males and females are maximum at L5 with 20.7mm and 17.5mm respectively, the present study reveals that the height of pedicles is maximum also at L5,with 16.19mm (male)and 16.12mm(female) respectively. Amonoo-Kuofi convinced that there was a cephalocaudal gradient of increase (from L1-L5) of the pedicles (height) in males and females, this later result corresponding with our study. But it is quite intriguing that, some studies showed a gradually decrease in height of pedicles (male & female) from L1-L5., [37] (T1 to L5), [38] (L1 to L5) and [39] (L1 to L5).The Pedicle index (PI) ratio that presented in our study is a unique radiologic measurement. The pedicle index curve is more correlated to both the PDW (r2 = 0.447) and the PDH (r2 = 0.675) curve, especially at lumbar levels of L1–L3, PDW curve in this ratio depicted positive linear relationship with Pedicle index and PDH curve depicted negative linear relationship with Pedicle index, This indicates that the mean PI ratio can be used as a very important measure for representing properties of pedicle diameters. Moreover, the fact that there is no significant difference between males and females in PI ratios at each spine level means that the PI ratio is a constant measurement along the lumbar spine, regardless of gender. Vertebral body width(VBW) represents a very important variable as it is playing a big role in the measurements of the spinal canal ratio and pedicle ratio or (CT ratio).The mean values of the (VBW) of the lumbar vertebrae for our participants showed gradually increase from(L1 to L5) ,L1(33.09), L2 (33.87), L3(35.37),then increased in L4 (37.72) and L5 (43.77). When these mean value in(mm) have been compared with other different races and ethnicities in the world (Figure12)the results demonstrated that there were greater variation in the mean values of vertebra levels of our study (36.77mm) and others such as; Nigeria (46.48mm) , Israel(43.56),Burkina Faso (40.78mm),Nepal (40.40mm) and Egypt(40.20mm).

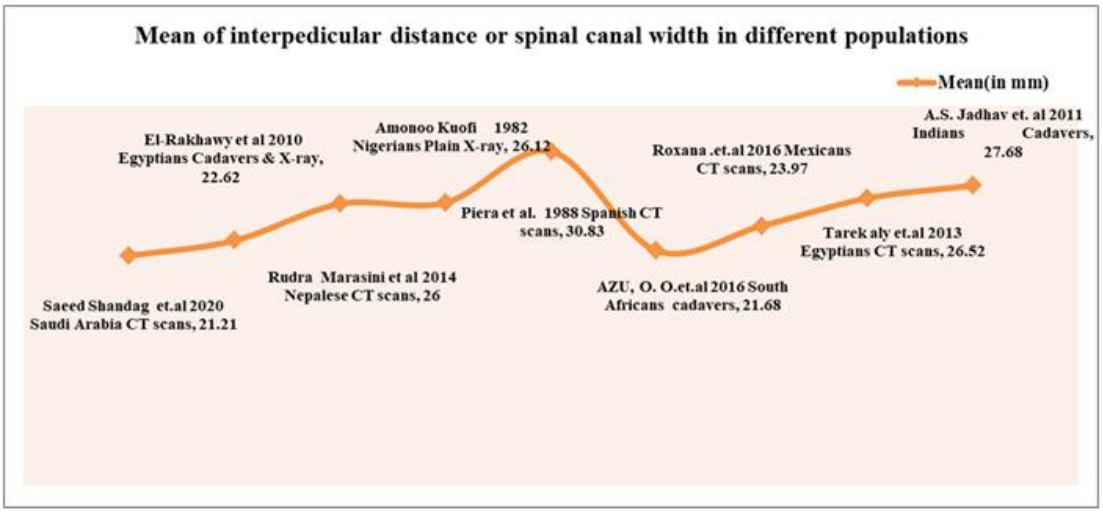


(Figure12)The (VBW) of the lumbar vertebrae of the present study compared with the data from previous studies.

The CT ratio(Pedicle ratio) is a unique radiologic ratio measurement that first performed [14].(Figure 7) this linear graph figure demonstrated the mean values of PDW and VBW and the ratio of (PDW/VBWX100) for each level (L1–L5) there was a correlation between the mean of PDW , the mean of VBW, whereas (Figure 8) had observed that the ratio curve is more similar to the PDW curve (r2 = 0.619) than the VBW (r2 = 0.264) curve, especially at lumbar levels of L1–L2,PDW curve showed highly positive linear relationship with Pedicle ratio and VBW curve showed negative linear relationship with Pedicle ratio. The above data for CT ratios might be useful backup data for developmental anatomic study particularly if future studies show it to be highly reliable in multiple racial and ethnic groups and over a large range of body sizes.

Spinal canal width (SCW) represents a very important role in the measurement of the spinal canal ratio in order to detect spinal stenosis. Spinal stenosis, is a rising phenomenon due to aging of the population, and has been diagnosed increasingly in the last two decades [40]). This disease is most typically due to degenerative changes [41]).(SCW) is a reliable index for the assessment of the size of the canal [42].Measurements of the (SCW) may be a preliminary, but useful aid in the diagnosis of the lumbar canal stenosis syndrome [43].There is not enough evidence to conclude that male scores (21.36 ±1.24,21.21±2.00,22.04±2.90 and 20.85±2.89) are any different from female scores (21.14±1.11,20.78±2.14,21.45±2.15,20.96±2.37 and 20.45±2.55), t(198) = (L1=1.34, P =0.18), (L2= 1.48, P= 0.14),(L3= 1.36,P=0.11), (L4= 1.79,P=0.08)and(L5= 1.05,P=.0.30) respectively. The largest mean lumbar (SCW) was seen at vertebral level L3 in both males (22.04±2.90) and females (21.45±2.15) and the least was at vertebral level L5 in both males (20.85±2.89) and females (20.45±2.55).The mean SCW was larger in males than in females and the difference was statistically insignificant (p >0.05).The mean SCW of the pedicle in males was 21.42 ± 2.40 mm and in females was 20.96 ± 2.06 mm.

Overall measurements of the (SCW) of the lumbar vertebral among Jazan population showed between the levels, L1(21.247mm), reduced in L2 to(20.997mm),then increased in L3(21.8190mm),then reduced gradually at L4 (21.3055mm),L5(20.6520mm)our measurements in (SCW) are totally not in line with that of other studies.(neither increase gradually from(L1-L5) nor decrease).Comparing with other different races and ethnicities in the world the mean of our result (21.21mm) was in close relation with some population(Figure13 though the difference in methods used between our study and others such as; south Africans(21.68mm) [44], Egyptians (22.62mm) [40]and Mexicans [45] (23.97mm).There was a large variation between our (SCW) mean value and some populations such as; Spanish [46] (30.83mm) and Nigerians.[43] (26.12mm).



(Figure13) The (SCW) of the lumbar vertebrae of the present study compared with the data from previous studies.

the result of the spinal canal ratio.(Table:6) at each lumbar vertebral level demonstrated that in the total ratio there was gradually decreasing from L1 (mean ± SD 64.20 ± 3.83%),L2 (mean ± SD 61.98 ± 3.35%),L3(mean ± SD 61.62 ± 3.19 %),L4(mean ± SD 57.00 ± 3.94%) and L5(mean ± SD 47.17 ± 4.6 %).The tables also demonstrated that spinal canal ratio were greater in males than in females at each lumbar level with exception of (L1 and L3) which were greater in females for a little bit. lowest (spinal canal ratio) was observed at L5 (mean ± SD 46.93 ± 4.66 %) and the highest ratio was at L1 (mean± SD 64.25± 3.05 %),both the smallest and largest pedicle ratios were observed among females. Our study also demonstrated that the ratio between the width of spinal canal and lumbar vertebral body is 0.6 at L1, L2 and L3 but it becomes 0.5 at L4 and 0.4 at L5, this signifies that in L4 andL5 levels the vertebral bodies are larger than the canal ,so the spinal canals are thus susceptible to stenosis.

V. Conclusion

In the measurements of *pedicle index ratio,* our study convinced that there was gradually increasing from L1 to L5 in the pedicle index ratio and the result among gender explained that pedicle index ratio were greater in females than males at each lumbar level with exception of L1 which was greater in males, and the pedicle index curve is more similar to both the PDH curve and the PDW curve, especially at lumbar levels of L1–L3.This study also demonstrated that *CT ratio or pedicle ratio* is gradually increasing from L1 to L5.Pedicle ratio were greater in females than males at each lumbar level with exception of L1 which was greater in males for a little bit. The result of the *spinal canal ratio* demonstrated that in the total ratio there was gradually decreasing from L1 to L5 and the spinal canal ratio were greater in males than in females at each lumbar level with exception of (L1 and L3) which were greater in females for a little bit. The vertebral ratio was not found constant at any vertebral level in both sexes. Based on the study results, it can be stated that measurements of lumbar vertebral ratios are useful for use as it provides precisions measurements of vertebral parameters to represent the characteristics of the lumbar vertebra. Furthermore, that CT metric scan is used as a trustable radiologic imaging modality as it yields precise measurements of the vertebral parameters particularly the PDW. The anatomical knowledge of the lumbar vertebral ratios may be helpful for the clinicians in the images interpretation and preparing plan for treatment of lumbar spine anomalies. It represents also greater a baseline data for Jazan population which can be assisted in the further research activities.

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